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Application No. : 09/524,227  
Applicant : Irene T. Spitsberg  
Filed: : March 13, 2000  
TC/Art Unit: : 1762  
Examiner : Wesley D. Markham

Confirmation No. 6813

Docket No. : 13DV-13004  
Customer No. : 30952

Commissioner for Patents  
P.O. Box 1450  
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RESPONSE UNDER 37 CFR §1.116

In the Office Action of April 5, 2004 (Paper No. 20040330), the Examiner reviewed claims 1-20 of the above-identified US Patent Application<sup>1</sup>, with the result that all of the claims were rejected for a second time under 35 USC §103. Applicant respectfully requests reconsideration.

Applicant's invention is directed to a process of improving the spallation resistance of a thermal barrier coating (TBC 26) by modifying the grain structure of a diffusion aluminide bond coat (24) on which the TBC (26) is deposited (page 1, lines

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<sup>1</sup> Applicants previously canceled claims 21-39 in the Amendment filed January 16, 2004.

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10-13). As deposited, the bond coat (24) has columnar grains (32) with grain boundaries (34) exposed at the surface of the bond coat (24). At least the surface of the bond coat (24) is then recrystallized so that new grains (42,48,50) form at the bond coat surface, replacing the original columnar grains (32).

As taught by Applicant at page 3, lines 2-5 and page 10, lines 25-29, TBC (26) deposited on a diffusion aluminide bond coat (24) spalls as a result of cracks that initiate and propagate within an alumina scale (36) that grows on the bond coat surface and/or at the interface between the bond coat (24) and alumina scale (36). TBC spallation does not occur as a result of cracks propagating through the diffusion aluminide bond coat (24).

Independent claims 1, 11, and 20 and their dependent claims 2-10 and 12-19 were rejected under 35 USC §103(a) as being unpatentable over Applicant's admitted prior art (AAPA) in view of Japanese patent JP 01-180959 A to Nakamura et al. (Nakamura), either alone or in further view of one or more of U.S. Patent Nos. 4,514,469 to Loersch et al. (Loersch), 4,512,817 to Duhl et al. (Duhl), and 5,238,752 to Duderstadt et al. (Duderstadt). Under each of the §103 rejections, the Examiner explained that the AAPA discloses a thermal barrier coating system 20 comprising a diffusion aluminide bond coat 24 deposited on a component 10 so that the bond coat 24 is characterized by substantially columnar grains 32 and grain boundaries 34 thereof are exposed at the surface of the bond coat 24. The Examiner acknowledged that the

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AAPA failed to explicitly teach modifying the grain structure of the bond coat 24 by recrystallizing the bond coat 24 so that new grains form at the surface of the bond coat 24, but then cited Nakamura for teaching

after depositing a diffusion coating layer of Al (i.e., an aluminide bond coat) on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is shot-peened and then heated to a temperature at or above the recrystallization temperature of the coating layer, thereby causing recrystallized grains (i.e., "new grains") to form on the surface of the diffusion coating layer (Abstract). This recrystallization process advantageously allows the component/coating (1) to have an improved thermal fatigue resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract).

From this, the Examiner concluded that it would have been obvious to a person having ordinary skill in the art at the time the invention was made

to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component/blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance, (2) a low crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system).

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However, the Examiner's explanation for the existence of motivation to modify the teachings of the AAPA with the teachings of Nakamura relies on solving problems that do not exist within the AAPA's TBC system 20. The AAPA teaches that spallation of the TBC 26 is the result of thermal fatigue and crack propagation that occurs at and within the alumina scale 36 - TBC spallation does not occur as a result of thermal fatigue, cracking or peeling of the bond coat 24 itself. All of the benefits ascribed to Nakamura's teachings concern improving the thermal fatigue resistance, reducing crack propagation speed, and increasing the peel-off resistance of a diffusion aluminide coating. Such problems solved by Nakamura's teachings do not exist in the AAPA's TBC system 20, and therefore there is no motivation to apply Nakamura's teachings to the AAPA's TBC system 20.

Nakamura teaches that improved thermal fatigue resistance, reduced crack propagation speed, and increased peel-off resistance of a coating layer can be improved by recrystallizing the very coating layer in which such improvements are sought. Therefore, at best Nakamura's teachings could be argued to suggest recrystallizing the AAPA's alumina scale 36 or TBC 26 - the coating layers through which cracks propagate - as opposed to the bond coat 24 that underlies the scale 36 and TBC 26.

In view of the above, while TBC spallation on a diffusion aluminide bond coat 24 is due to a fatigue mechanism, this mechanism is not the result of crack

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propagation through the bond coat 24 or its grain boundaries. Therefore, it would be totally unexpected that recrystallization of the bond coat 24 could have anything to do with TBC life. It was only through Applicant's investigations that Applicant determined that bond coat recrystallization can change the stress state at the bond coat grain boundaries where the grain boundaries intersect the bond coat surface, to the extent that TBC spallation resistance is improved.

Finally, regarding the Examiner's observation that the process steps in Applicant's claims are typical for recrystallization - such as Nakamura - the purpose of recrystallization of a metal coating is to affect grain size, which is well known to be related to crack propagation through metal coatings. However, previous to Applicant's teachings, grain size of a diffusion aluminide bond coat 24 was not known to have any affect on crack initiation and propagation through a TBC 26 deposited on the bond coat 24.

In summary, though the Examiner concluded that the teachings of Nakamura provide sufficient motivation to combine the AAPA and Nakamura based on a reasonable expectation of success, the motivation that the Examiner alludes to for recrystallizing the AAPA's bond coat 24 doesn't exist, because the problem it would solve - inhibiting crack propagation and peeling of the AAPA's bond coat 24 - doesn't exist. Because those skilled in the art are aware of this, they would not find any motivation in Nakamura to recrystallize the AAPA's bond coat 24.

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In view of the above, Applicant believes that, other than Applicant's teachings, there is no motivation to combine the teachings of the AAPA and Nakamura. Applicant therefore respectfully requests withdrawal of the first rejection to the claims under 35 USC §103(a).

From the above, it is also apparent that Loersch, Duhl, and Duderstadt cannot be said to supplement the teachings of the AAPA and Nakamura in order to arrive at Applicant's invention, as none of these additional references provide motivation for recrystallizing a diffusion aluminide bond coat used to adhere a TBC. Therefore, Applicant respectfully requests withdrawal of the remaining claim rejections under 35 USC §103(a).


#### Closing

In view of the above, Applicant believes that all issues outstanding from the Office Action have been addressed, and that the claims define patentable novelty over all the references, alone or in combination, of record. It is therefore respectfully requested that this patent application be given favorable reconsideration.

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Should the Examiner have any questions with respect to any matter now of record, Applicant's representative may be reached at (219) 462-4999.

Respectfully submitted,

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